IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of	
Applicant(s)	: Faur-Ghenciu et al.
Serial No.	: 10/617,146
Filed	: July 10, 2003
Title	: HIGH ACTIVITY WATER GAS SHIFT CATALYSTS BASED ON PLATINUM GROUP METALS AND CERIUM-CONTAINING OXIDES
Docket No.	: GMC 0025 PA / 42320.29/GP-302809
Examiner	: K. Handal
Art Unit	: 1797

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

DECLARATION OF ANCA FAUR-GHENCIU, NATHAN E. TRUSTY, MARK R. FEAVIOUR, JESSICA G. REINKINGH, PHILLIP SHADY, AND PAUL J. ANDERSEN UNDER 37 C.F.R. 1.131

Anca Faur-Ghenciu, Nathan E. Trusty, Mark R. Feaviour, Jessica G. Reinkingh, Phillip Shady, and Paul J. Andersen, the applicants in the above-identified patent application, declare as follows:

1. We are the inventors of claims 1-61 of the above-identified patent application and inventors of the subject matter described and claimed therein.

2. Prior to May 9, 2001, we reduced the present invention to practice as evidenced by Exhibits A-D attached hereto.

3. Exhibit A is a copy of pages 131, 133, 136, 137, 139-141, 161, and 167 of Laboratory Notebook No. 1875. These pages show the preparation of several catalysts of the present invention. Pages 131, 133, 136, 137, 139, 140, 141, and 161 have adhesive labels attached showing receipt of samples for testing by Johnson Matthey Analytical Services. Exhibit

A has been redacted to delete dates and other proprietary information.

4. Exhibit B is a copy of an email from Anca Ghenciu to Stephen Bransfield and Nathan Trusty, with a cc to Coral Isikci. There is an attachment showing the Powder Catalyst List and Test Procedure. The list shows the Catalyst ID, which corresponds to the page number from the laboratory notebook, the catalyst composition, and the FPR number. The FPR number is assigned when the sample is tested. Exhibit B has been redacted to delete dates and other proprietary information.

5. Exhibit C is a copy of an email from Anca Ghenciu to Stephen Bransfield, with a cc to Sailesh Mullapudi and Nathan Trusty. There is an attachment showing an updated Powder Catalyst List and Test Procedure with the Catalyst ID, the catalyst composition, and the FPR number. Exhibit C has been redacted to delete dates and other proprietary information.

6. Exhibit D is a copy of an email from Anca Ghenciu to Stephen Bransfield and Nathan Trusty. Two attachments show the Powder Catalyst List and Test Procedure with the Catalyst ID, the catalyst composition, and the FPR number. There are also attachments of graphs showing the test results for various samples. Exhibit D has been redacted to delete dates and other proprietary information.

7. Exhibit E shows the correlation between the Catalyst ID, the FPR number. and the catalyst compositions shown in Exhibits A-D.

8. Each of the dates deleted from Exhibits A-D is prior to May 9, 2001. All work relating to the conception and reduction to practice of this invention was carried out in a WTO country.

Serial No. 10/617146
Docket No. GMC 0025 PA/40320.29/GP-302809

The declarants further state that the above statements were made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this application or any patent resulting therefrom.

Date: March 4, 2008.

Anca Faur-Ghenciu

Date: _____

Nathan E. Trusty

Date: _____

Mark. R. Feaviour

Date: _____

Jessica G. Reinkingh

Date: _____

Phillip Shady

Date: _____

Paul J. Andersen

Serial No. 10/617146
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Date: _____ Anca Faur-Ghenciu

Date: 3-4-08 Nathan E. Trusty
Nathan E. Trusty

Date: _____ Mark. R. Feaviour

Date: _____ Jessica G. Reinkingh

Date: _____ Phillip Shady

Date: _____ Paul J. Andersen

The declarants further state that the above statements were made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this application or any patent resulting therefrom.

Date: _____ Anca Faur-Ghenciu

Date: _____ Nathan E. Trusty

Date: 3/3/08 M. Feaviour Mark. R. Feaviour

Date: _____ Jessica G. Reinkingh

Date: _____ Phillip Shady

Date: _____ Paul J. Andersen

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Date: _____ _____
Anca Faur-Ghenciu

Date: _____ _____
Nathan E. Trusty

Date: _____ _____
Mark R. Feaviour

Date: March 8, 2008 _____
Jessica G. Reinkingh

Date: _____ _____
Phillip Shady

Date: _____ _____
Paul J. Andersen

Serial No. 10/617146
Docket No. GMC 0025 PA/40320.29/GP-302809

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Date: _____ Anca Faur-Ghenciu

Date: _____ Nathan E. Trusty

Date: _____ Mark. R. Feaviour

Date: _____ Jessica G. Reinkingh

Date: March 4, 2008 Phillip Shady

Date: _____ Paul J. Andersen

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Date: _____ Anca Faur-Ghenciu

Date: _____ Nathan E. Trusty

Date: _____ Mark. R. Feaviour

Date: _____ Jessica G. Reinkingh

Date: _____ Phillip Shady

Date: 3/4/2008 Paul J. Andersen

Work continued from Page

1757-131-1

$\frac{X}{40} = \frac{1.4839}{1.3508}$ 45.6 Tot Vol

I.W.C. = 1.3008g Powder
DI = 1.4839

$(40g\ La_2O_3CeO_2 + X)\ .01 = X$

$.4g = X(.99)$

$X = .404g\ Pd / \frac{.14933g\ Pt/g\ Pt(NO_3)}{150.79} = 2.679\ 2.72g\ Pd(NO_3)_2$

① Mix DI + Pd as Nitrat lot # ~~2146~~ 718-66666001 to 40.0g Powder as La_2O_3 CeO_3 In Excess. 2 10%
② Mix well and Place In drying Oven - For 2hr Then fired @ 500°C for 2hr - @125°C → 500 10°C/min

:ter: TRUSTY Logged:

57-131-1 INHOUSE

Take 40g Powder and @add to It Pd @1% and Pt @.5% Via Co Imp.

$Xpd = .404g\ Pd / .15079\ g/g = 2.679g\ Pd\ @(NO_3)_2$ = 1.8896ml

$Xpt = .202g\ Pt / .14933\ g/g = 1.353g\ Pt$ as Nitrat = .8655ml

① Mix Pt & Pd into DI H2O ~ 42g of DI Mix well
② Add Soln to Powder. Slowly w/ good mixing. Be careful to make sure all Powder is blended in w/ PGM. @125 2hr
③ Place In drying Oven and fire for 500°C 2hr 10°C/min @125 → 500

1757-131-2

Analytical Services

Submitter: TRUSTY Logged:

NTIFIC BINDERY PRODUCTIONS CHICAGO ID: INHOUSE 1757-131-2 Sub Id: Continued to Page

ATURE DATE

OSED TO AND UNDERSTOOD BY DATE WITNESS DATE

EXHIBIT A

1% Pt on .5% Cs

Take 4g of $La_2Ce_2O_7$ Powder
+ 2.70g of Pt as $Pt(NO_3)_2$ = 18ml - Tot Vol = 43.8ml
+

$X_{Cs} = .20g\,Cs \frac{132.905g\,Cs}{194.91}$ will use Cs Nitrate instead of Cs Acetate.

$X_{Cs} = .20g\,Cs \frac{178.91g\,CsNO_3}{132.90g\,Cs} = .293g\,Co(NO_3)$ Act = .381g

+ Mix w/ Total Volume of $Pt(NO_3)$ + DI for a Co Impregnation.
* Note Soln had to be mixed w/ stir plate to dissolve the Cs Nitrat.
+ Mix soln Gradually onto Powder. Until total Mixture is Saturate.

+ Place In drying oven @ 125°C for 2hrs.
Note: During the Dry step take saturated powder out and mix w/ spatula so that wet Cake can dry evenly.

Temp start from 0°C @ 26°/min. know oven available downstairs for firing. 23

Lab ID 1757-133-4

Analytical Services

Submitter: TRUSTY Logged:

ID: INHOUSE 1757-133-4 Sub Id:

SIGNATURE DATE

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

136

Preps. 1757-136-1

IW. Condition →

~~6.2621g~~ 101

2.7818g DI 17.76aml ; 40g

Take Pd @ 1% on 40g cf

$\left(40g\,|\,01\,(6La\}+X\right).01 = X$

17.76 - 1.89

$\frac{.04g}{.99} = X_{Pd}$

$X_{Pd} = 40.4g / .1507 = 2.68g$ Pd as Nitrate

① Mix (Pd Nitrate) w/ DI (17.69g DI Excess) to 40g

Btwt = 40.15g

② Mix well to avoid dry spots.

③ Placed Wet Cake in dry oven overnight
4:15pm → Till 5:00Am.

④ Remove and Place in Firing oven @ 500°C 2hr.

Note: Its important to Break up cake prior to firing.

M. Trusty

Analytical Services

Submitter: TRUSTY
ID: 1757-136-1
Logged:
Sub Id:

From: Anca Ghenciu
To: Trusty, Nathan
Date:
Subject: Impregnation

Nathan,

30-50 g of each, depending on how much powder we have.
I would make them by co-impregnation, but successive impreg is ok

1 1%Pd/La2O3-CeO2
2 1%Pd-0.5%Pt/La2O3-CeO2
3 1%Pt-0.5%Cu/La2O3-CeO2
4 1%Pt-0.5%Cs/La2O3-CeO2

⑤ Allows Powder to Fire more evenly.

M. T

Work continued from Page

Catalyst ID 1757-137-2 [1% Pd - 5% Pt/]

Pd:Pt: Done as Co-Impregnation — 39.5g Tot. After 500°C

① Take 40g of ... and Pla ce in to container

② w/ I.W. being 17.76ml total Volume in Excess
See I.W condition on 1757-136

Xpd = .404g Pd / .15079g/g = 2.68g Pd as Nitrate
Xpt = .202g Pt / .14933g/g = 1.352g Pt as Nitrate

Pt as Pt(NO3)2 Tot Volume of PGM = 2.75ml - 17.76ml Tot vol of I.W cond.
lot-71866666001

Tot DI Needed = 15.00ml

③ Add DI of 15ml to PGM solution - [Mix well]

③ Take ... and Gradually Mix Soln slowly
④ Add all Soln to ~~(until complete)~~ make sure there are no clumps in saturated Mixture.
⑤ Place in drying Oven @ 125°C 8.15am
⑥ In Rf Oven @ 90.15Am. 2hr @ 500°C ← Brk cake up Prior to firing Use a Spatula.

US In House

Dissolved better in solution. Darker in color

Analytical Services

Submitter: TRUSTY Logged:

ID: 1757-137-2 Sub Id:

Work continued to Page

SIGNATURE DATE

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Work continued from Page

Pt on La Ce

1757-139@-2

Total Vol = 17.76ml

① Take 40g of In House Material

$S = 1.5632$

$.4g = X(.99)$

$X_{Pt} = .404g / .14933 g\ Pt(NO_3)_2 = 2.679g\ Pt(NO_3)_2$

② Take 17.76ml DI - Vol of Pt = 16.05ml DI

Mix DI + Pt together.

③ Add Pt + DI to In house La Ce Oxide gradually.

* Wet Cake will form. Very Hard to mix w/spat
* Continue Adding Mixture to powder until saturate completely and all soln. in.

④ Be careful that all powder is mixed ~~thr~~ well. (Powder) Cake has tendency to avoid soln by hiding in Pocket.

⑤ Place wet Cake in Drying oven @ 125°C

This cake was (will be) left over night prior to firing

⑥ Place Dried Cake in to oven. Prior to firing dried cake break up wet cake ~~is~~ well.

600°C for 2hr

Analytical Services

Submitter: TRUSTY Logged:

ID: INHOUSE 1757-139-2 Sub Id:

140 Impregnation Using Pt @ 1%

Pt @ Nitrate C

① 40g of material and Place into Crucible

② Xpt = .404g / .14933 gPt/g = 2.705g Pt or 1.73mL

Same Lot
718 66666 001
S = 1.5631

Lot concentration
149.33g/kg

Mix Pt Nitrate + DI H_2O to a total volume of 17.76mL to be ~10% Excess soln.

③ Add 16.029mL of DI H_2O to $Pt(NO_3)_2$

④ Begin adding soln to powder gradually will become hard but once it is saturated make sure all clumps are crushed to avoid any powder from be catalyzed evenly. ~~Place~~

⑤ Place in drying oven of 125°C for 2 hr Timer - 9:10am

Cat ID#1757-140-1

⑥ Place in oven @ for 2hr @ 500°C

Analytical Services

Submitter: TRUSTY Logged:

ID: PT: 1757-140-1 Sub Id:

M

Work continued from Page

Take 40g Pt. Lable from (RP)
Lot # 98160/98

$X_{Pt} = 2.404 / .1493 = 2.705\text{g } Pt(NO_3)_2$

$X_{Cs} = .202\text{g Cs} / \frac{194.91\text{ Cs}(NO_3)_2}{132.9\text{ Cs}} = \boxed{.2962\text{g } Cs(NO_3)_2}$

① Take $Cs(NO_3)_2$ + 16.029 g DI H_2O and Mix by Stir plat until dissolved completely.
~< 3 Minutes to dissolve.
Note order of Addition ~~Pt~~ DI + Cs will Soln Crashed if are Placed together and Pt added to.
$Pt(NO_3)_2$ + $Cs(NO_3)_2$

② Once Mixture is thoroughly mixed add to

③ Mixture ~~is~~ will visually appear to be liquid. Remember this is an excess soln.

④ Drying oven @ 125°C 2 hr Time = 10:00Am.

1757-141-1 IDH

Analytical Services

Submitter: TRUSTY Logged:

ID: PT:CS 1757-141-1 Sub Id:

Work continued to Page

SIGNATURE DATE

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2% Pt / Cs Nitrate 2%

Work continued from Page

① Take 1757-159 and Grind material into fine Powder

② Take 40g of 1757-159 (.2% Pt only)
See Cs Calculation on Pg 160B.

Take .118g Cs Nitrate and Dissolve it in 17.76g DI

③ Dissolve $Cs(NO_3)_2$ + DI and Add to Pt. powder slowly.

④ Once Soln. Is completely added to Powder & will Good Homoginuity Place in drying oven 2hr.

⑤ fire @ 500°C 2hr.

Calc ID = 1757-161A

Take and Place 2% Pt By IW.

DW of
2.247g = 95
1.487 X = 62.87

Take 95g and Place 2% $Pt(NO_3)_2$ to Soln. to It.

95g. + Xpt = 1.9987g / .14399 = 13.96g $Pt(NO_3)_2$
= 8.61ml - 62.87 = 54.26ml DI.

① Mix DI H_2O + PGM well

② Add PGM + DI to Gradually until all soln is mixed in.
a) over shot / Calculation error from IW Condition.
Placed In Air Drying Oven Down stairs @ 125°C
Dried well w/ Intermittent stirring.

③ Place in firing oven @ ~~125~~ 500°C 2hr. Calc ID = 1757-161B

Work continued to Page

SIGNATURE N. Tarnuth DATE

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Work continued from Page

Inv of $\frac{2.5284g}{1.3402g\ DI} = \frac{30g}{x}$ TV = 15.90g DI or 14.60+ PGM.

Take 30g of material. and Place 10%/Ce Sample or

X-Pt = .303g/.1433 = 2.029g $Pt(NO_3)_2$ or 1.298ml

① Place $Pt(NO_3)_2$ + DI H_2O on ~~to~~ to 30g of spread Slowly. Making sure all Pt solu is evenly placed on powder.

② After adding all Solu. Place wet Caking in a drying oven @ 125°C. This Powder will be in oven upto 15 overnight.

③ Next Day. Placed in oven for 2hr @ 500°C Starting Time 5:25 Am.

Assay # 35147 1757-167A

Cs on 2%Pt. Take 1757-166A and Place CsCEX

① Take 41.4g Amol. Pt2 TV = 27.39mL Soln @ .002

$X_{Cs} = .08296 / \frac{194.91\ Cs(NO_3)_2}{132.91\ Cs} = .12167g\ Cs(NO_3)_2$ Act = .1204g

① See Procedure 1757-166A.

Note: This material will be ~~Pt~~ Cs/Pt.

a) Impreg's w/ Buffer CEX @ 150g/L

a) Pt CEX Dry fire

b) Cs CEX Dry fire.

Assay #

1757-167B

Work continued to Page

SIGNATURE DATE

DISCLOSED TO AND UNDERSTOOD BY DATE WITNESS DATE

Prior, Patricia

From: Anca Ghenciu [ghencia.EP.DEVON@matthey.com]
Sent:
To: Stephen Bransfield; Nathan Trusty
Cc: Coral Isikci
Subject: Powder tests

Attachments: RxnTest_SCAT-FC_F .doc

RxnTest_SCAT-FC_

Steve, Nathan,

Although it seems odd, I am writing all these messages now (Saturday night) because on Monday morning by the time I get here you will be having many things already achieved and I may be too late.

For the powder reactor, there are four tests I would like to have run before I leave to UK (see Table attached): lines 13, 21, 20, 23, run in this order. You may have already tested line #13, I am not sure since I do not have the data for that. Could you test these on Monday and Tuesday AM? If not, whatever it is possible.

There is no need to repeat 1%Pt/CeO2 (C480-51B, Sonning) (it used to be line #16) for the time being, but if it is possible, after you set-up the GC, I would like to have the following tested using both MS and GC, so that we can validate the GC for the powder reactor:
- Cu-Zn powder
- line #8 (cat 1757-137-2); we had postponed this initially
- line#22 (cat C480-75A)
- repeat line #16 (best to date, 1757-142-12)

All above 45-60 mesh, 1 g cat, 1 g cord, 10 slmp total flow, concentrations as before. When you send me the test results, please also copy Nathan form now on, so that we all stay in the loop.

Nathan,
For the above tests, Steve will only need 2 g (1cat+1cord) of 1757-142-12, and also the memorable jar of Cu-Zn and a jar of cordierite, both at 45-60 mesh, so that he can validate the GC with it from time to time.

Thank you very much,

Anca

EXHIBIT B

Powder Catalyst List and Test Procedure, Matrix 3_LT

	Catalyst ID	**Catalyst Composition**	
		Cu-ZnO commercial (Sud-Chemie)	3FPR95
1	1757-129	MgO-Al2O3(P)/Ni/Fe	3FPR94
2	1757-131-1	1%Pd/75%La2O3-25%CeO2	3FPR96
3	1757-131A2	1%Pd-0.5%Pt/75%La2O3-25%CeO2	3FPR97
4	1757-132-3	1%Pt-0.5%Cu/75%La2O3-25%CeO2	3FPR98
5	1757-133-4	1%Pt-0.5%Cs/75%La2O3-25%CeO2	3FPR99
6	1757-139-2	1%Pt/75%La2O3-25%CeO2	3FPR104
7	1757-136-1	1%Pd/25%La2O3-75%CeO2	3FPR105
8	1757-137-2	1%Pd-0.5%Pt/ 25%La2O3-75%CeO2	
9	1757-138-3	1%Pt-0.5%Cu/ 25%La2O3-75%CeO2	3FPR106
10	1757-141-1	1%Pt-0.5%Cs/ 25%La2O3-75%CeO2	3FPR107
11	1757-140-1	1%Pt/ 25%La2O3-75%CeO2	3FPR108
12	1757-142-12	1%Pt/CeO2 (	3FPR109
13	1757-14x-13	1%Pt-0.5%Cu/CeO2	Already tested??
14	1757-143-14	1%Pt-0.5%Cs/CeO2	3FPR110
15	1757-144-15	**1%Pt-0.5%Cs-0.5%Cu**/CeO2	3FPR111
16	1757-142-12	1%Pt/CeO2 (RERUN)	Re-run
17	C480-82	10%(20%Pd/Fe2O3)/Al2O3	3FPR100
18	C480-74	5%Pd/Fe2O3	3FPR102
19	C480-90A	1%Au/TiO2 (gray)	3FPR103
20	C480-83	1%Au/TiO2 (lilac)	
21	C480-90B	1%Au/1%Co/TiO2 (gray)	
22	C480-75A	1%Au/Fe2O3	
23	C480-75B	5%Au/Fe2O3	
24	C480-71	MoS2/La2O3-Al2O3	3FPR70

Test procedure:

1 g catalyst, 1 g cordierite, each sieved to 45-60 mesh, well mixed.
Total flow **1.125 SLPM**
Inlet mole %: 8%CO, 30%H2O, 10%CO2, 32.5%H2, 1%CH4, 18.5% N2 (balance)
Steady state temperatures: **150**, 175, 200, 225, 250, 275, 300, 350, 400, 450, 500, 550°C.

Please save the spent samples in new vials, with the run # on the vial.

Prior, Patricia

From: Anca Ghenciu [ghencia.EP.DEVON@matthey.com]
Sent:
To: Stephen Bransfield
Cc: Sailesh Mullapudi; Nathan Trusty
Subject: updated table

Attachments: RxnTest_SCAT-FC_ .doc

RxnTest_SCAT-FC_

Steve,
I have updated the Table. Nathan will bring more catalysts tomorrow.
Thanks,
Anca

EXHIBIT
C

Powder Catalyst List and Test Procedure, Matrix 4_LT

	Catalyst ID	Catalyst Composition	Test Conditions	Test #
	C18-7		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR122**
	C480-96A	1%Pt/La-CeOx	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	Repeat of FPR121 **FPR123**
	C480-74		(45-60 mesh, **2g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150-500°C**	Repeat of FPR120 **FPR124**
	C480-100A		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2.5slpm, 150°-500°C**	
	C480-100B		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2.5slpm, 150°-500°C**	
	1757-4-149-1A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR126**
	1757-4-149-2A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR125**
	1757-4-149-3A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR127**
	C480-110B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR128**
	C480-68A		durability test, (45-60 mesh, **1g +1g cordierite**), 8%CO, **32.5%H2**, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150-275°C, 3 ramps**	**FPR129**
	C480-110A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR130**
	1875-01		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR131**
	1875-02		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR132**
	1875-03		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4,	**FPR133**

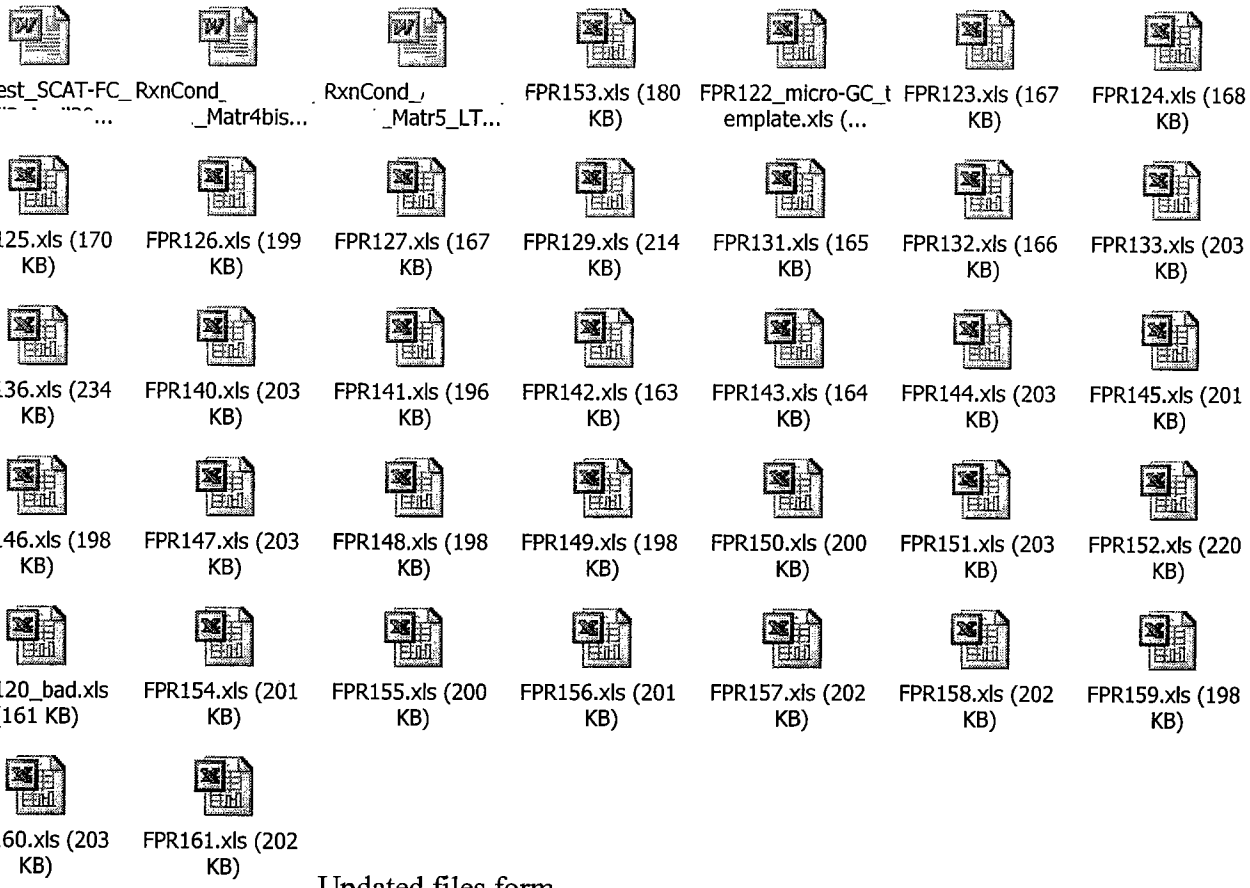
			1.125 slpm, 150°-500°C	
	1875-04		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR136**
	C480-112A	Sonning reformer (Li-0.5%Rh/)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR135**
	C480-112B	Sonning reformer (Cs,0.5%Rh/)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR139**
	C480-112C	Sonning reformer (Cs,1%Rh/)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR138**
	1757-159		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR140**
	1757-161A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR142**
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
Calc 400°C, 2 hr.	1875-09		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	1757-159B	2%Pt/La-CeO2	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR141**
	1757-160B	2%Pt/0.2%Cs/La-CeO2 This is a 0.2%Cs/1757-159B	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR143**
Calc 400°C, 2 hr.	1875-10		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	1757-162A	0.5%Rh/La-CeO2		**FPR144**
	1757-160A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	1757-161B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	1757-162B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	

	1875-05		To test later	
	Nathan, please fill in ID		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
Calc. 400°C, 2hr.	1875-07		To test later	
	Nathan		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	Nathan		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	Anca		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	

Prior, Patricia

From: Anca Ghenciu [qhencia.EP.DEVON@matthey.com]
Sent:
To: Stephen Bransfield; Nathan Trusty
Subject: Updated files from

Attachments: RxnTest_SCAT-FC_ .doc; RxnCond_ l_Matr4bis.doc; RxnCond_ _Matr5_LT.doc; FPR153.xls; FPR122_micro-GC_template.xls; FPR123.xls; FPR124.xls; FPR125.xls; FPR126.xls; FPR127.xls; FPR129.xls; FPR131.xls; FPR132.xls; FPR133.xls; FPR136.xls; FPR140.xls; FPR141.xls; FPR142.xls; FPR143.xls; FPR144.xls; FPR145.xls; FPR146.xls; FPR147.xls; FPR148.xls; FPR149.xls; FPR150.xls; FPR151.xls; FPR152.xls; FPR120_bad.xls; FPR154.xls; FPR155.xls; FPR156.xls; FPR157.xls; FPR158.xls; FPR159.xls; FPR160.xls; FPR161.xls



Updated files form

Matrix 4_LT ( )
Matrix 5_LT ( ) - current Matrix 4bis_LT (Pt/Cu-Zn UCI)

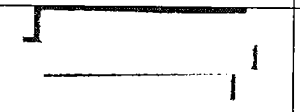
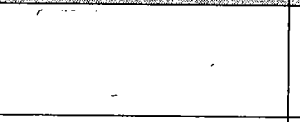
The attached have the correction for methanation (taking into account the CH4 forms from CO). Please replace the old versions with these. You can use any of these (for instance, the template) for future tests.
If there is any missing file between FPR120 and FPR161, please let me know.
Anca

EXHIBIT D

Powder Catalyst List and Test Procedure, Matrix 4_LT

	Catalyst ID	Catalyst Composition	Test Conditions	Test #
	C18-7		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR122**
	C480-96A	1%Pt/La-CeOx	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	Repeat of FPR121 **FPR123**
	C480-74		(45-60 mesh, **2g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150-500°C**	Repeat of FPR120 **FPR124**
	C480-100A		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2.5slpm, 150°-500°C**	
	C480-100B		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2.5slpm, 150°-500°C**	
	1757-4-149-1A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR126**
	1757-4-149-2A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR125**
	1757-4-149-3A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR127**
	C480-110B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR128**
	C480-68A		durability test, (45-60 mesh, **1g +1g cordierite**), 8%CO, **32.5%H2**, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150-275°C, 3 ramps**	**FPR129**
	C480-110A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR130**
	1875-01		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR131**
	1875-02		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR132**
	1875-03		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4,	**FPR133**

			1.125 slpm, 150°-500°C	
	1875-04		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR136**
	C480-112A	Sonning reformer (Li-0.5%Rh/.)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR135**
	C480-112B	Sonning reformer (Cs,0.5%Rh/.)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR139**
	C480-112C	Sonning reformer (Cs,1%Rh/.)	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **2 slpm, 150°-500°C**	**FPR138**
	1757-159		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR140**
	1757-161A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR142**
	1757-164B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
Calc 400°C, 2 hr.	1875-09		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR149**
	1757-159B	2%Pt/La-CeO2 ( )	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR141**
	1757-160B	0.2%Cs/2%Pt/La-CeO2 This is a 0.2%Cs/1757-159B	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR143**
Calc 400°C, 2 hr.	1875-10		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	1757-162A	0.5%Rh/La-CeO2		**FPR144**
	1757-160A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR145**
	1757-161B	2%Pt/	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR146**
	1757-163B	2%Pt/0.2%Cs/	(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR148**

	1875-05		To test later	
	1757-162B		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	**FPR147**
Calc. 400°C, 2hr.	1875-07		To test later	
	1757-163A		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	Nathan		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
	Anca		(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1g +1g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, **1.125 slpm, 150°-500°C**	

Powder Catalyst List and Test Procedure, Matrix 5_LT

Rxn FPR152 (1 ;)

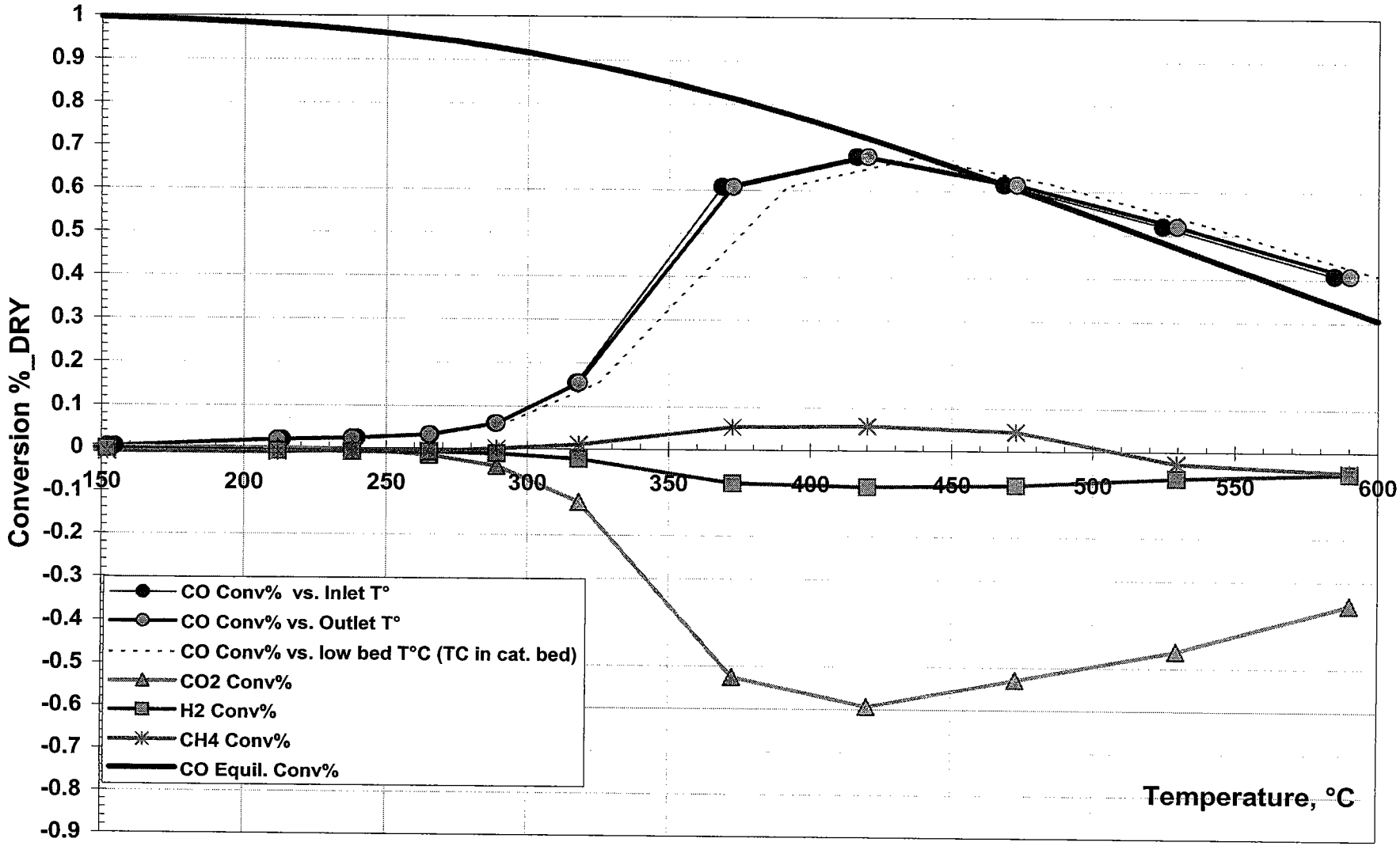
#	Catalyst ID	Catalyst Composition	Test Conditions	Test ID
	C480-100A		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **2.5 slpm, 150°-500°C**	
	C480-100B		(45-60 mesh, **2 g catalyst**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **2.5 slpm, 150°-500°C**	
			(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	1875-07		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	1757-163A		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR151 (already reported to GM at April meeting)
	1757-164A		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR153
	Prep		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	1757-164B		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR160
	Improvement			
	1757-166B	(2%Pt-0.2%Cs)/CeO2-ZrO2 ( ) (co-impreg, DI???) To be compared with seq. 1757-163B	(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR157
	Prep		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2,	

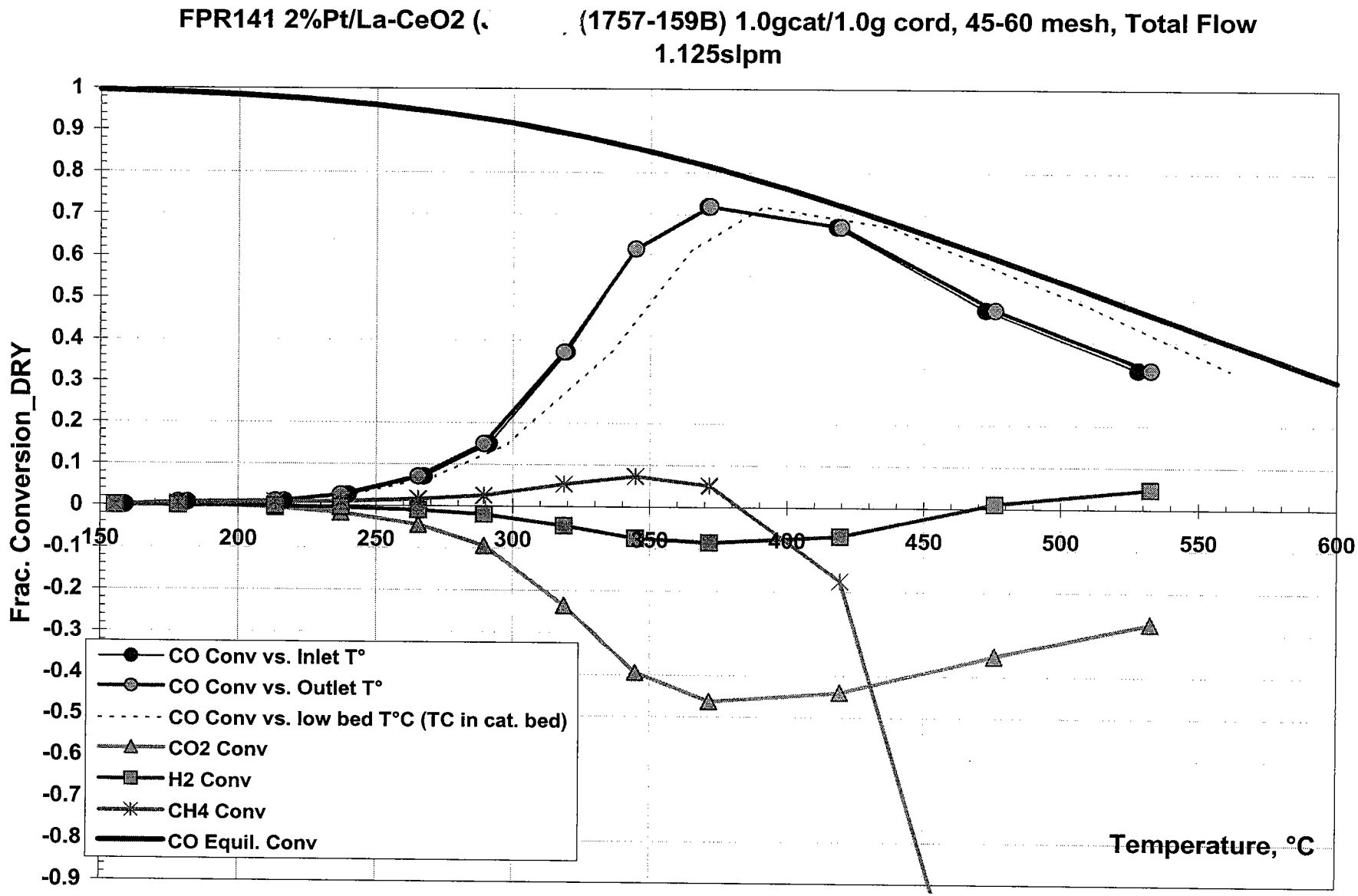
			1.125 slpm, 150°-500°C	
	Improvement			
	1757-166A	2%Pt/CeO2-ZrO2 (from citric acid To be compared with 1757-161B	(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR156
	1757-167B	0.2%Cs/2%Pt/CeO2-ZrO2 (, citric acid (both Pt and Cs)	(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	FPR159
	Prep		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	Prep		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	Prep		(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	Improvement			
			(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
			(45-60 mesh, **1 g catalyst + 1 g cordierite**), 8%CO, 32.5%H2, 30%H2O, 10%CO2, 1%CH4, bal. N2, **1.125 slpm, 150°-500°C**	
	Improvement		Phil Shady	
	1757-167A			FPR 158
	1757-168A			FPR161

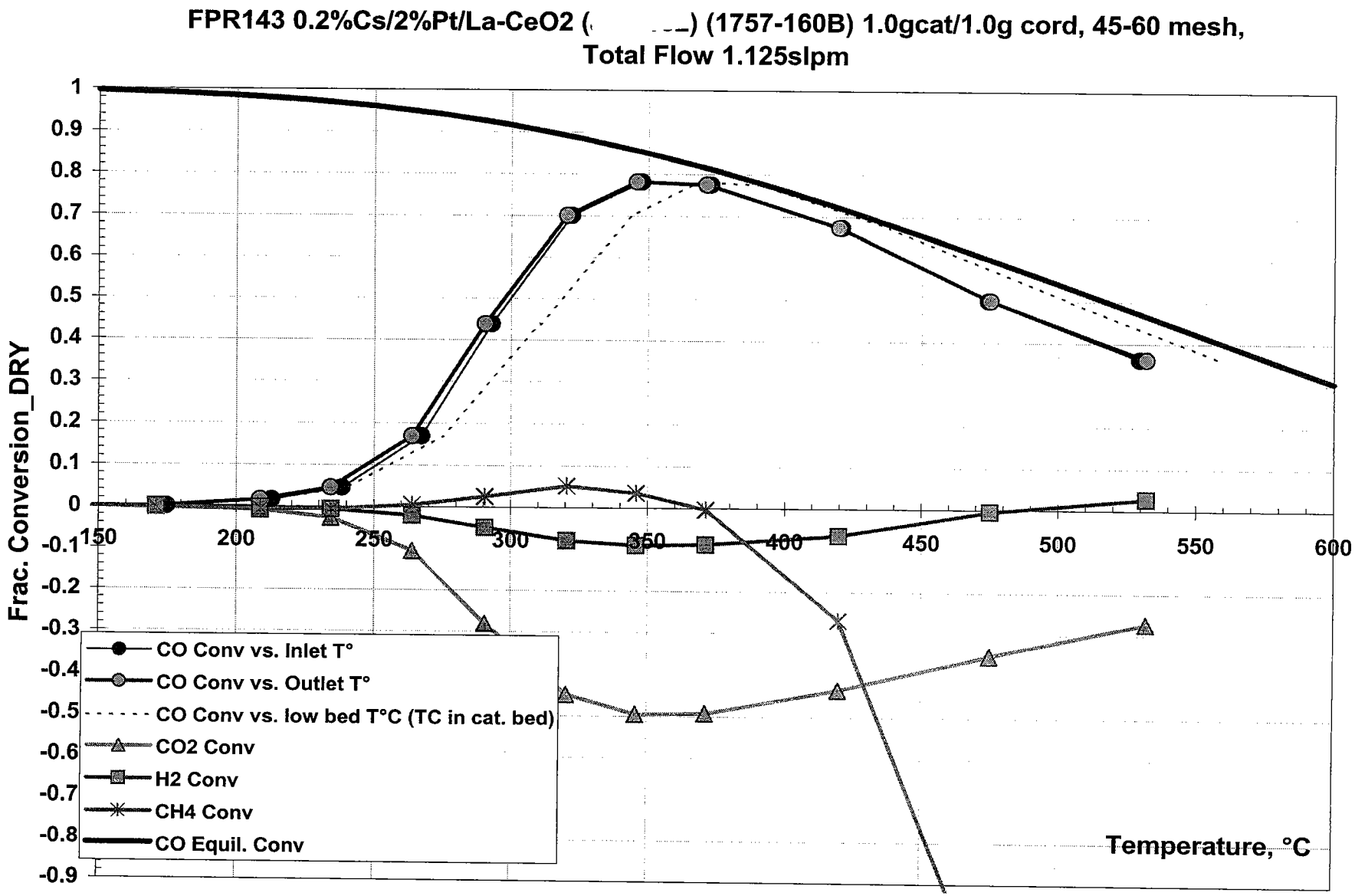
	New materials			
	CO selective oxidation materials (lit. data) – **no methanation catalyst**			
	Methanol synthesis (J. Frost)			
	Promotion of best Ce-Zr mixed oxide with Cu (copp) – **no methanation**			
	If above works,			

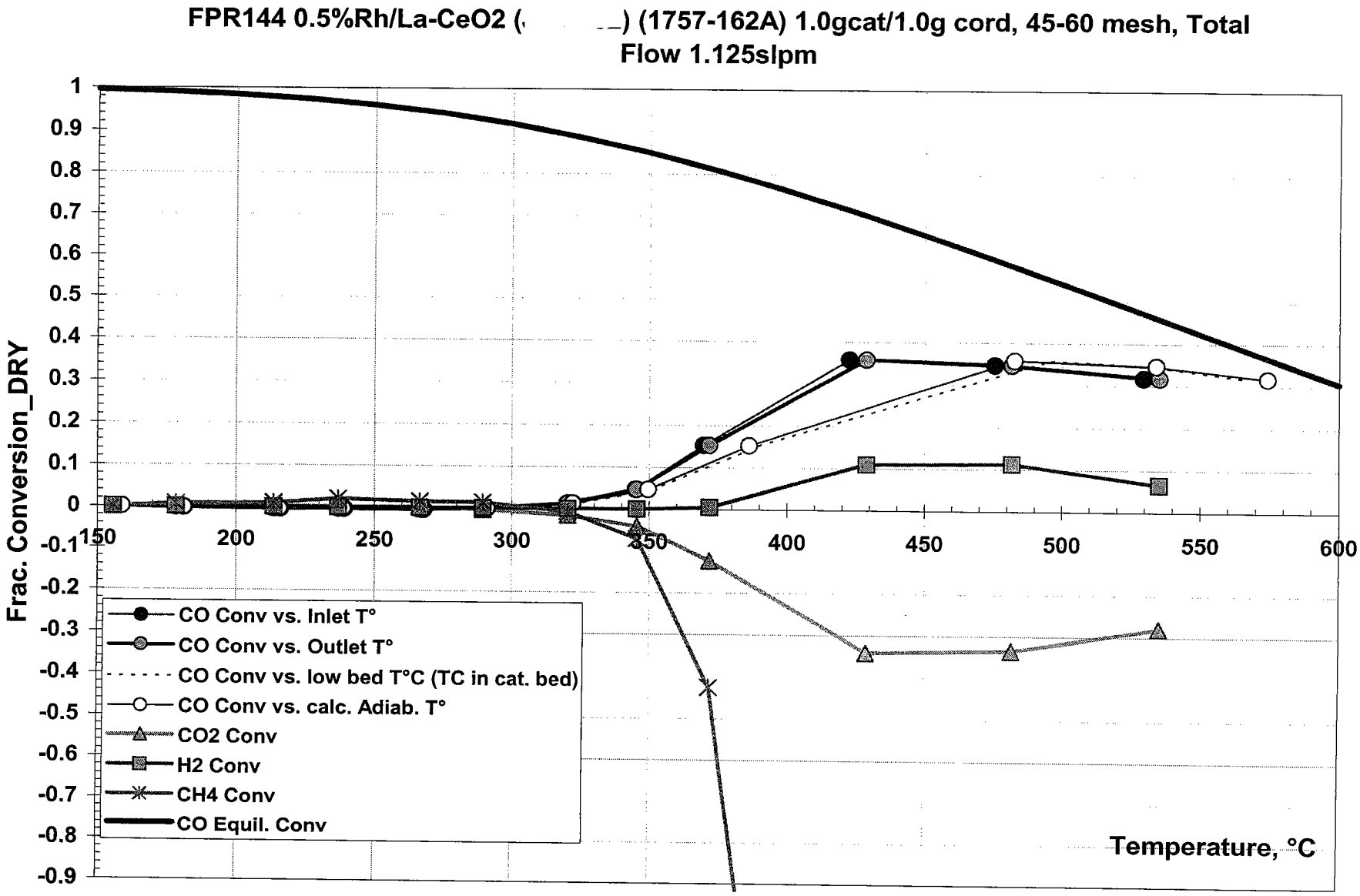
	Materials to be subjected to durability study (3 T ramps, new T schedule, very high **T~600°C)** - **no CH4 in the feed** - **high SV**	- - - - -		

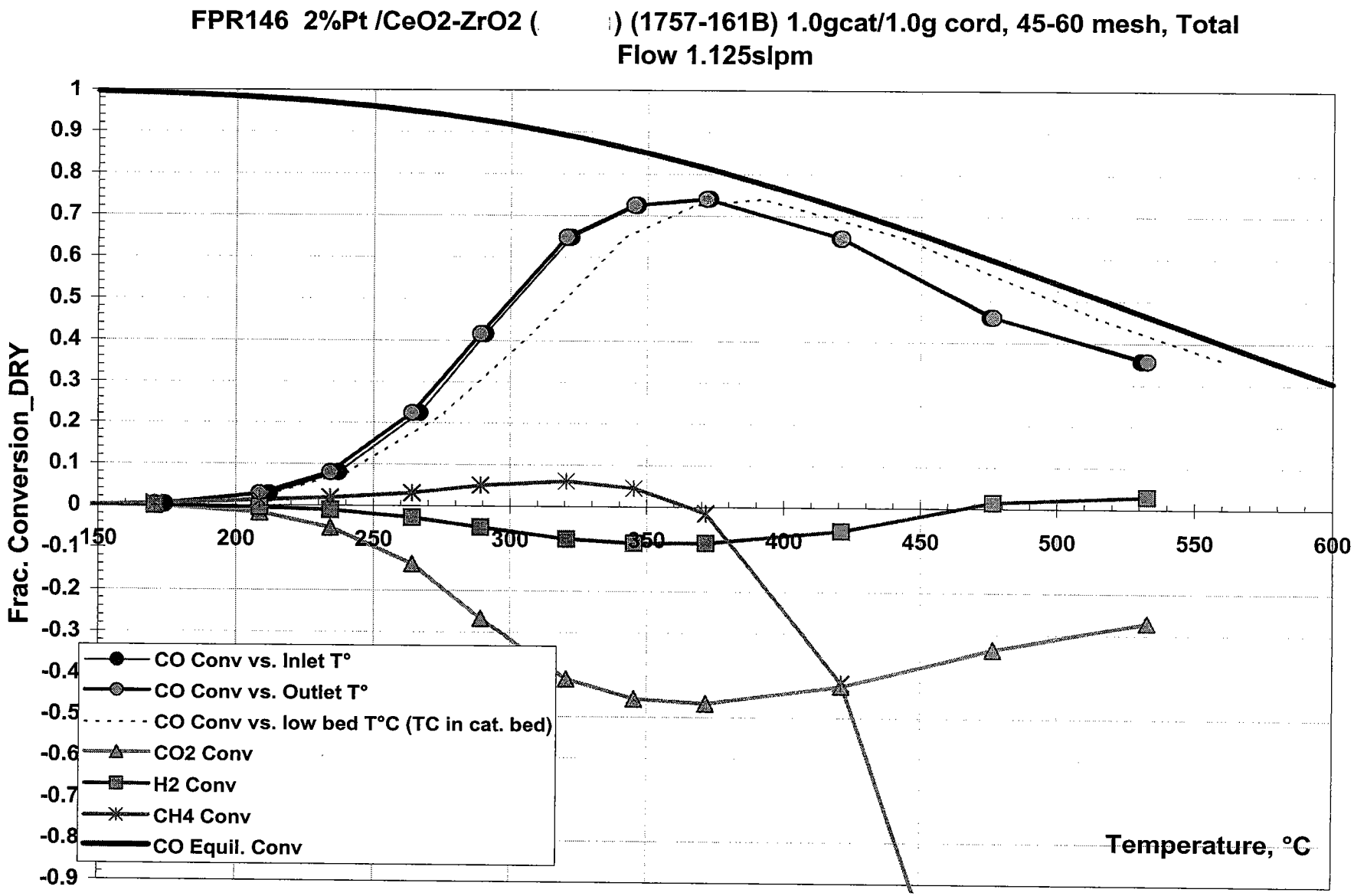
FPR123 1%Pt/La-CeOx (C480-96A) 1g cordierite/1g cat, 45-60 mesh, Total Flow 1.125slpm

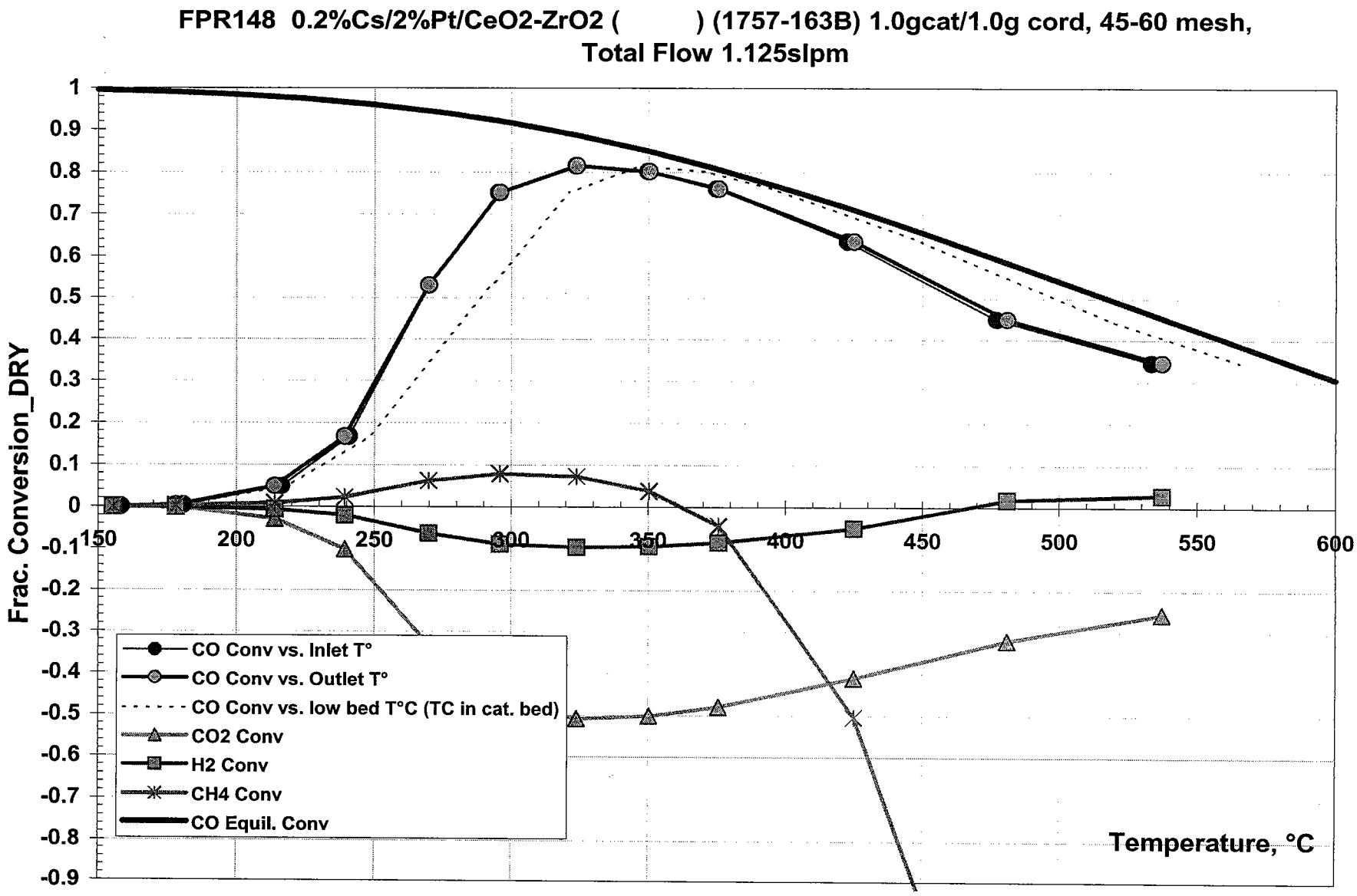


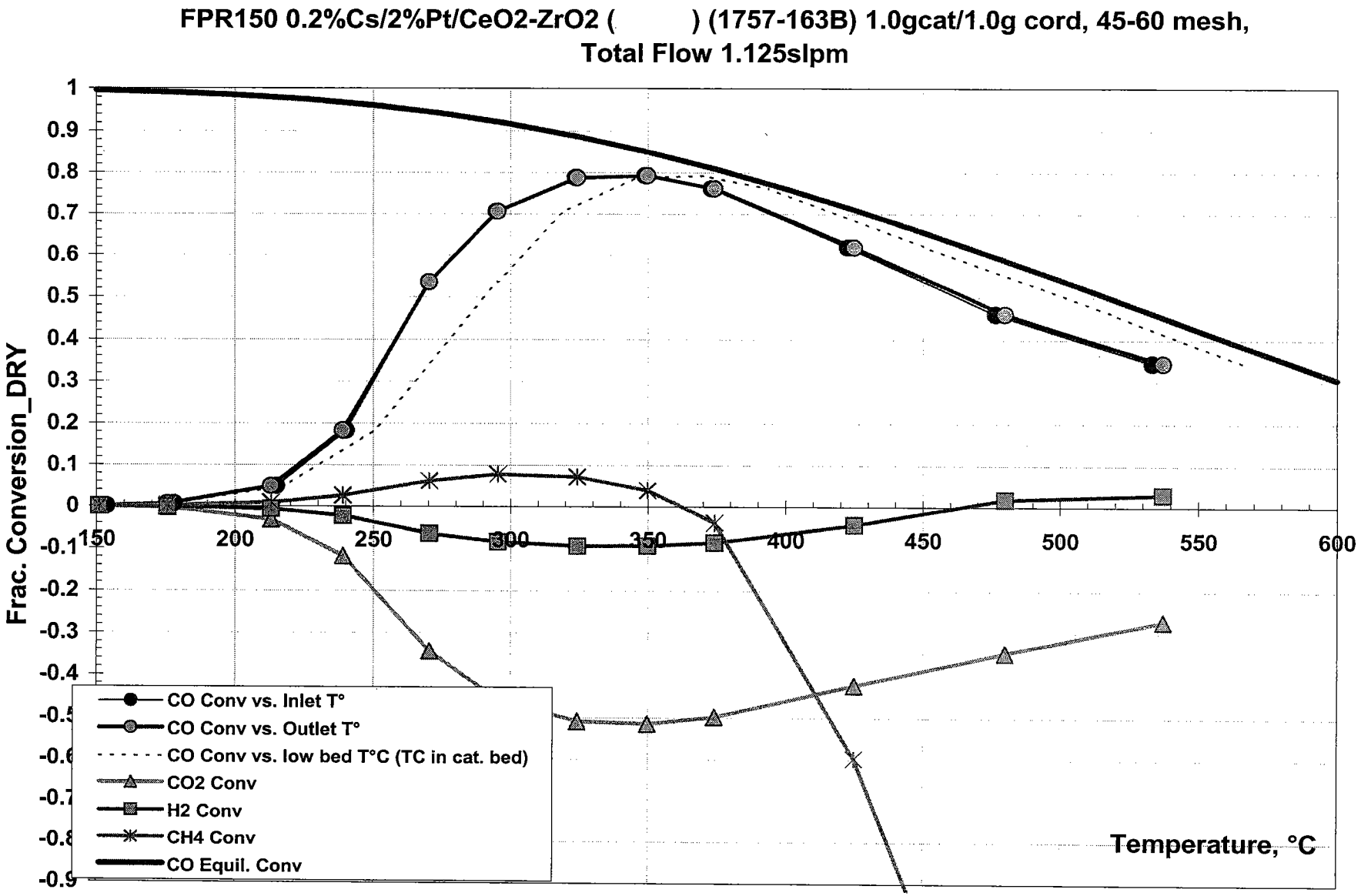

FPR141 2%Pt/La-CeO2 (. (1757-159B) 1.0gcat/1.0g cord, 45-60 mesh, Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv
Temperature, °C

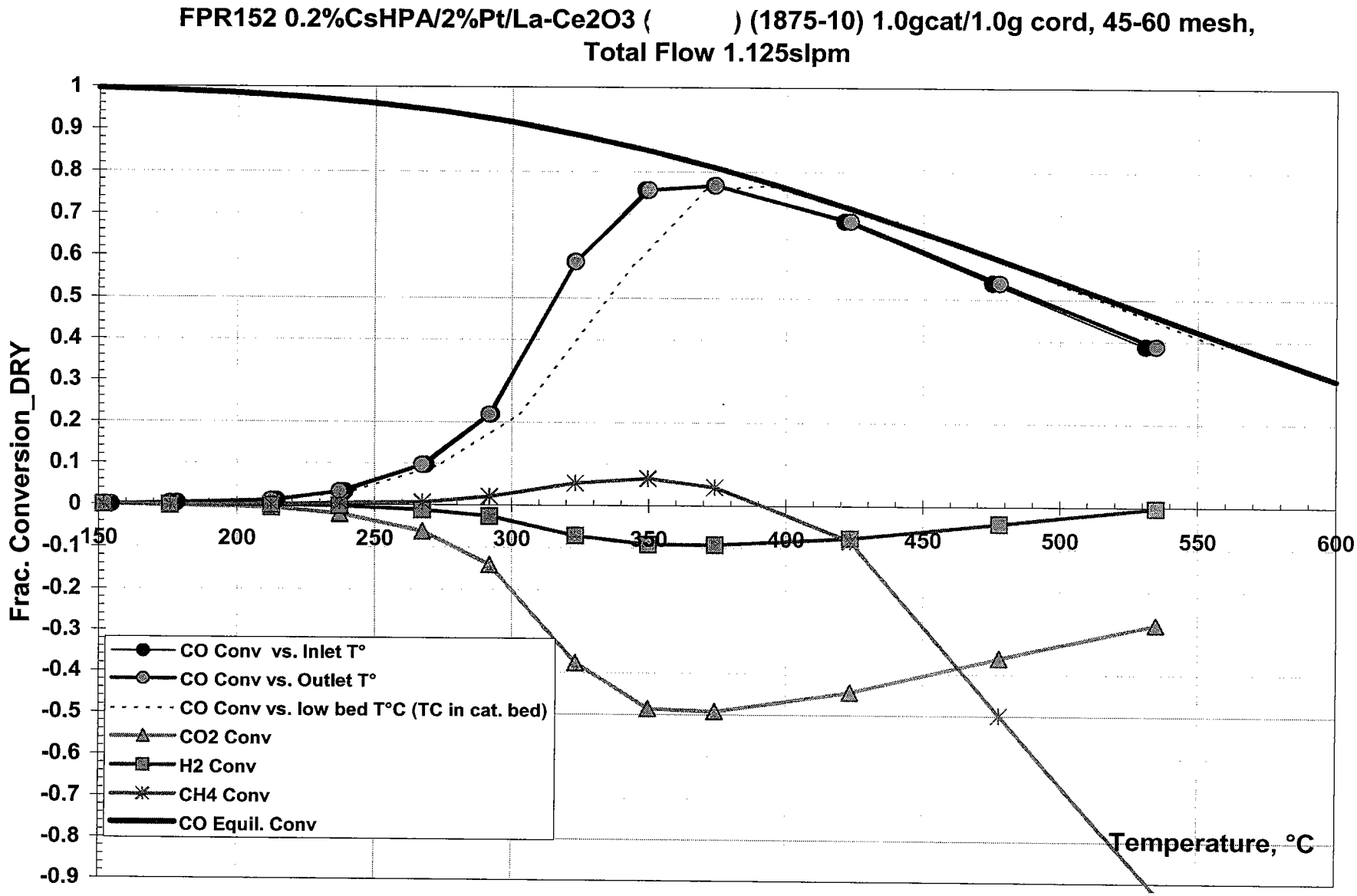

FPR143 0.2%Cs/2%Pt/La-CeO2 ( ) (1757-160B) 1.0gcat/1.0g cord, 45-60 mesh,
Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv

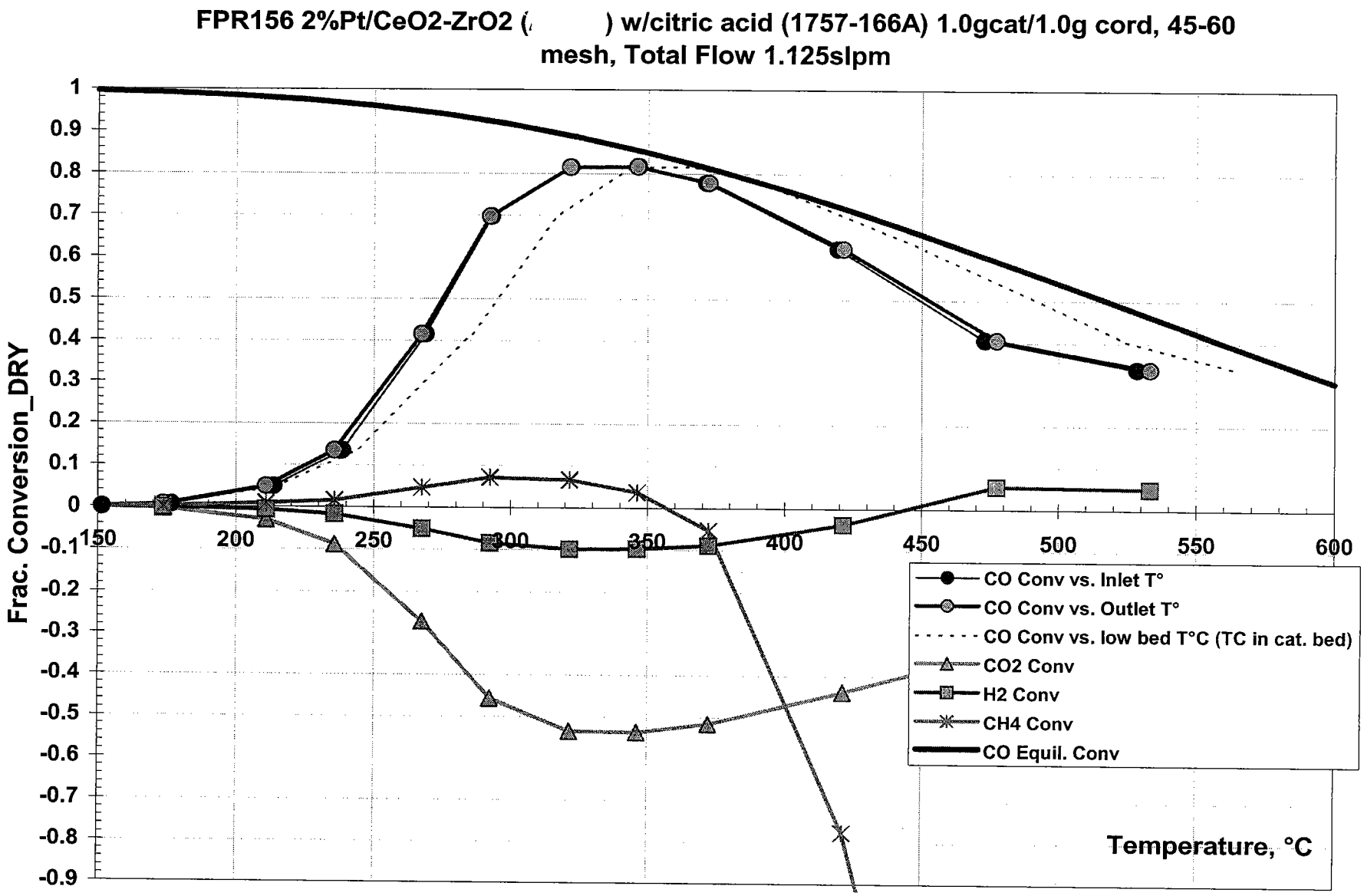

FPR144 0.5%Rh/La-CeO2 (_) (1757-162A) 1.0gcat/1.0g cord, 45-60 mesh, Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO Conv vs. calc. Adiab. T°
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv

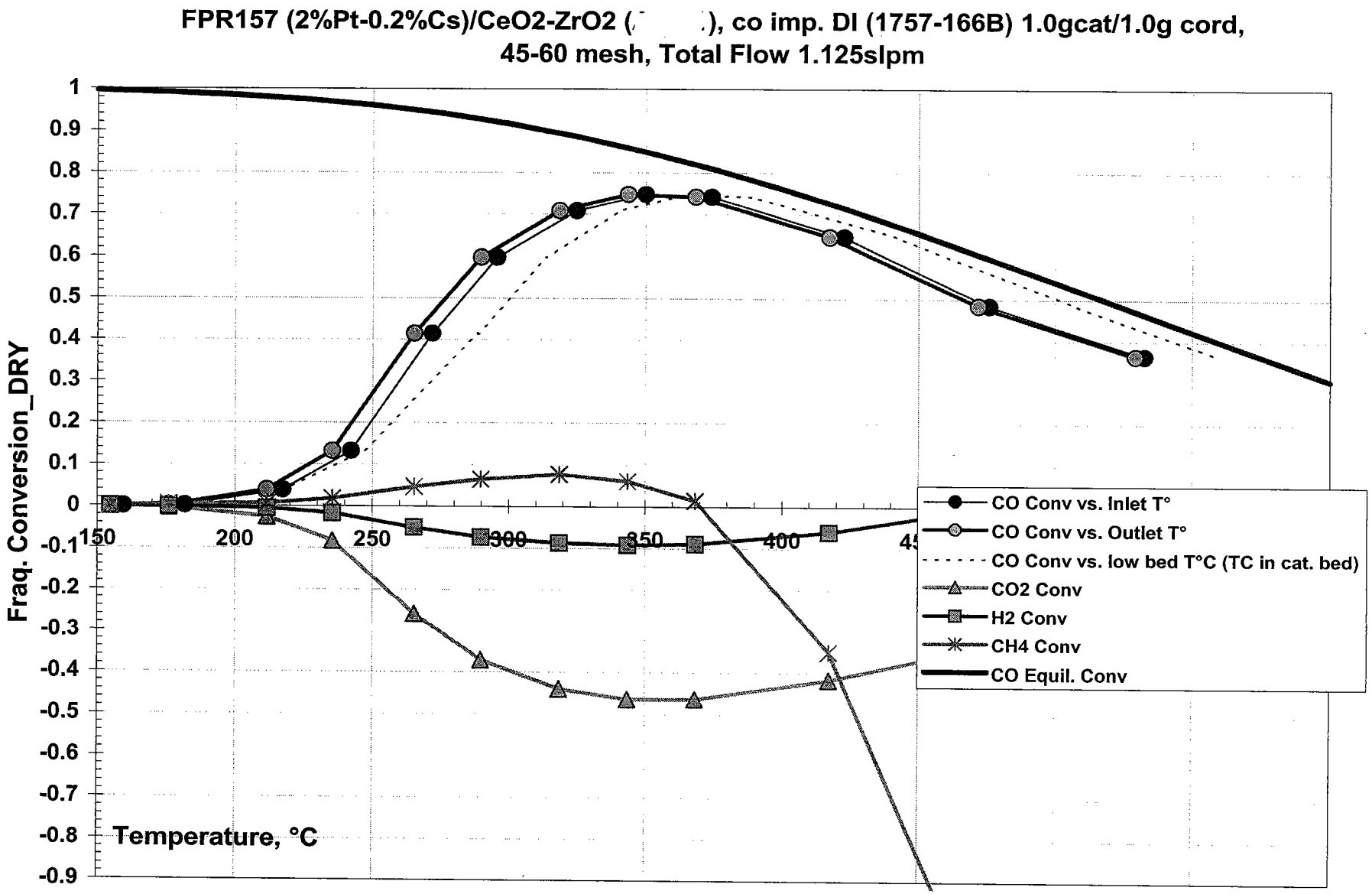

FPR146 2%Pt /CeO2-ZrO2 ( ) (1757-161B) 1.0gcat/1.0g cord, 45-60 mesh, Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv

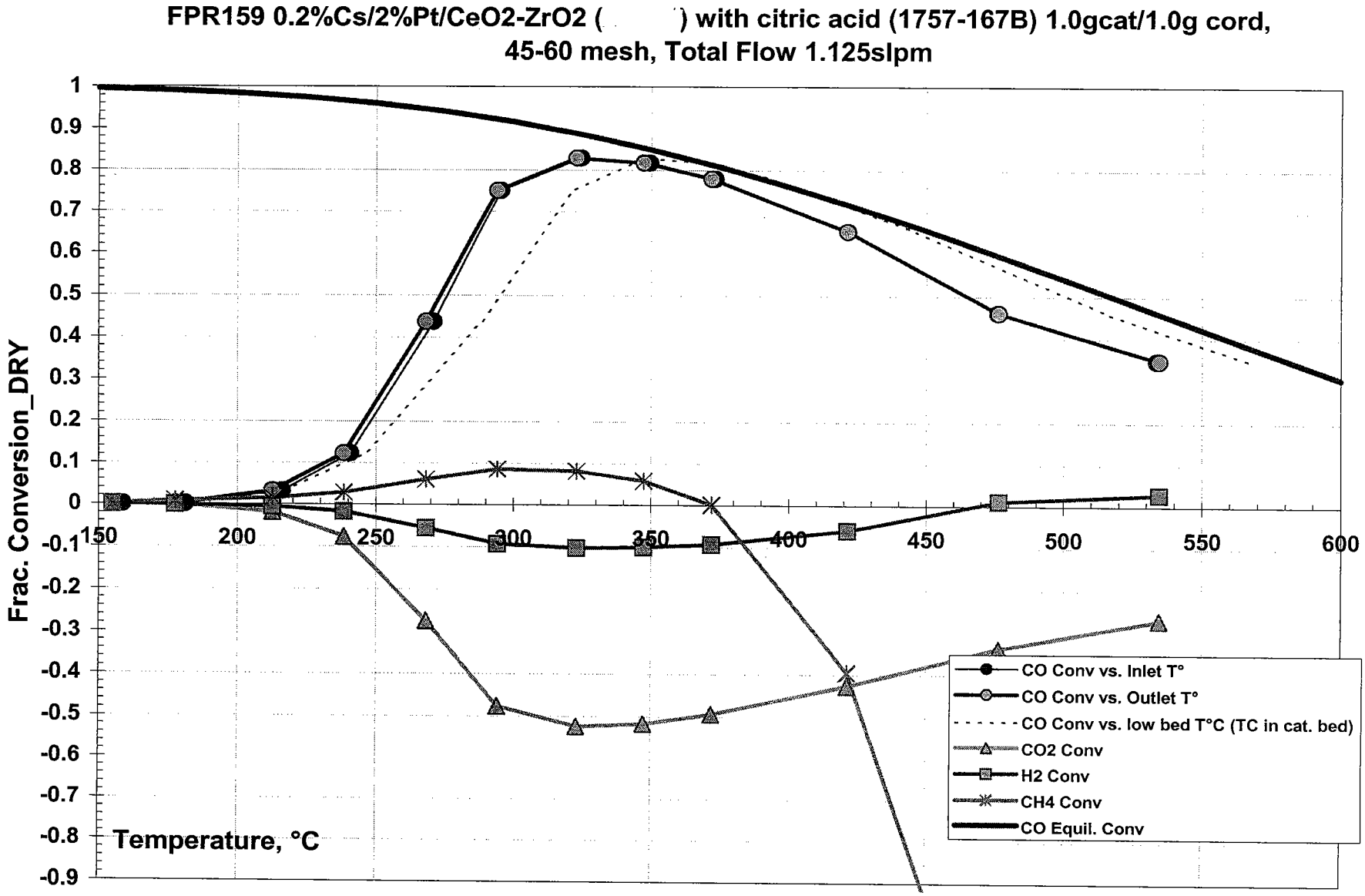

FPR148 0.2%Cs/2%Pt/CeO2-ZrO2 ( ) (1757-163B) 1.0gcat/1.0g cord, 45-60 mesh,
Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv


FPR150 0.2%Cs/2%Pt/CeO2-ZrO2 ( ) (1757-163B) 1.0gcat/1.0g cord, 45-60 mesh,
Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv


FPR152 0.2%CsHPA/2%Pt/La-Ce2O3 ( ) (1875-10) 1.0gcat/1.0g cord, 45-60 mesh,
Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv


FPR156 2%Pt/CeO2-ZrO2 ( ) w/citric acid (1757-166A) 1.0gcat/1.0g cord, 45-60 mesh, Total Flow 1.125slpm
Frac. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv


FPR157 (2%Pt-0.2%Cs)/CeO2-ZrO2 ( ), co imp. DI (1757-166B) 1.0gcat/1.0g cord,
45-60 mesh, Total Flow 1.125slpm
Fraq. Conversion_DRY
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
Temperature, °C
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv


FPR159 0.2%Cs/2%Pt/CeO2-ZrO2 ( ) with citric acid (1757-167B) 1.0gcat/1.0g cord, 45-60 mesh, Total Flow 1.125slpm
Frac. Conversion_DRY
Temperature, °C
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
150
200
250
300
350
400
450
500
550
600
CO Conv vs. Inlet T°
CO Conv vs. Outlet T°
CO Conv vs. low bed T°C (TC in cat. bed)
CO2 Conv
H2 Conv
CH4 Conv
CO Equil. Conv

Catalyst Compositions

La_2O_3/CeO_2

Catalyst ID	Test Number	Catalyst Composition
1757-131-1	FPR 96	1%Pd/75%La_2O_3-25%CeO_2
1757-131-2	FPR 97	1%Pd-0.5%Pt/75%La_2O_3-25%CeO_2
1757-133-4	FPR 99	1%Pt-0.5%Cs/75%La_2O_3-25%CeO_2
1757-139-2	FPR 104	1%Pt/75%La_2O_3-25%CeO_2
1757-136-1	FPR 105	1%Pd/25%La_2O_3-75%CeO_2
1757-137-2		1%Pd/0.5%Pt/25%La_2O_3-75%CeO_2
1757-141-1	FPR 107	1%Pt-0.5%Cs/ 25%La_2O_3-75%CeO_2
1757-140-1	FPR 108	1%Pt/ 25%La_2O_3-75%CeO_2
C480-96A	FPR 123	1%Pt/ %La_2O_3-%CeO_2
1757-159B	FPR 141	2%Pt/ 9%La_2O_3-91%CeO_2
1757-160B	FPR 143	2%Pt/0.2%Cs/9%La_2O_3-91%CeO_2
1757-162-A	FPR 144	0.5%Rh/9%La_2O_3-91%CeO_2
	FPR 152	0.2%CsHPA/2%Pt/9%La_2O_3-91%CeO_2

CeO_2/ZrO_2

Catalyst ID	Test Number	Catalyst Composition
C480-112A	FPR 135	Li-0.5%Rh/58%CeO_2-42%ZrO_2
C480-112B	FPR 139	Cs,0.5%Rh/58%CeO_2-42%ZrO_2
C480-112C	FPR 138	Cs,1%Rh/58%CeO_2-42%ZrO_2
1757-161B	FPR 146	2%Pt/58%CeO_2-42%ZrO_2
1757-162B	FPR 148	2%Pt/0.2%Cs/58%CeO_2-42%ZrO_2
1757-163B	FPR 150	2%Pt/0.2%Cs/58%CeO_2-42%ZrO_2
1757-166A	FPR 156	2%Pt/58%CeO_2-42%ZrO_2
1757-166B	FPR 157	2%Pt/0.2%Cs/58%CeO_2-42%ZrO_2
1757-167B	FPR 159	2%Pt/0.2%Cs/58%CeO_2-42%ZrO_2

EXHIBIT
E